

NON-PUBLIC?: N
ACCESSION #: 9303090544
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Duane Arnold Energy Center PAGE: 1 OF 05

DOCKET NUMBER: 05000331

TITLE: Turbine Trip and Reactor Scram Resulting From a
Circulating Water Pump Failure and Subsequent Loss of
Condenser Vacuum
EVENT DATE: 11/13/92 LER #: 92-018-01 REPORT DATE: 03/02/93

OTHER FACILITIES INVOLVED: None DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: Leonard L. Sueper, Principal TELEPHONE: (319) 851-7365
Technical Support Engineer

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: NN COMPONENT: P MANUFACTURER: B580
REPORTABLE NPRDS: Yes

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

Abstract: On November 13, 1992 at 0327, with reactor power in transition and decreasing from 100% of rated power, a turbine trip and reactor scram occurred due to the loss of condenser vacuum. The loss of vacuum was caused by the failure of the 'A' circulating water pump which allowed the flow from the remaining pump to recirculate back to the circulating water pump pit and bypass the condenser. Four (4) safety-relief valves lifted momentarily in response to the scram from high power. Plant and operator response to the transient was as expected.

The 'A' circulating water pump failed due to bolting failure on the pump bottom column - pump impeller case flange. The bolt failure was determined to be caused by stress corrosion cracking. The pump bolt material has been changed.

END OF ABSTRACT

TEXT PAGE 2 OF 5

I. DESCRIPTION OF EVENT:

On November 13, 1992 at 0326, with the reactor at approximately 100% power, the control room operators received a Condenser Hotwell High Level annunciator. The operators observed from control room chart recorders that condenser hotwell level had increased and that condenser vacuum was rapidly decaying. The operators immediately began reducing the speed of the reactor recirculating water pumps in an attempt to reduce reactor power to within the capacity of the main condenser.

The operators closely monitored condenser vacuum and received a condenser high pressure alarm (5 in. Hg setpoint) approximately 50 seconds after receiving the original hotwell high level alarm. Approximately 15 seconds later, a turbine trip occurred due to high condenser pressure (7.5 in. Hg setpoint), resulting in a reactor scram.

At the time of the scram, reactor power was decreasing from 100% of rated due to the manual reduction in recirc pump speed. As a result of the turbine trip which caused the scram, four (4) safety-relief valves momentarily lifted when reactor pressure increased to approximately 1138 psig. Following the initial pressure transient, the Electro-Hydraulic Control (EHC) system maintained reactor pressure at 940 psig via the turbine bypass valves. The turbine trip from greater than 30% rated power also caused the recirc pumps to trip. Reactor level was maintained between 163 and 206 inches above the top of active fuel during the event.

II. CAUSE OF EVENT

Twenty-eight (28) of forty (40) bolts attaching the circulating water bottom pump column to the impeller case assembly were found broken or missing. The failure of these bolts allowed the bottom pump column to separate from the impeller case. This separation placed stresses on the pump lower pump shaft and lower shaft bearing which subsequently led to their failure. The 'A' circulating water pump motor continued to run following the failure and the pump discharge valve, which is interlocked with the motor, remained open. This allowed the discharge of the operable 'B' pump to flow back to the circulating water pump pit through the failed pump, bypassing the main condenser. The increase in condenser hotwell level that first alerted the control room operators of a problem is believed to be due to flashing in the condenser level instrument legs. This could have occurred as a result of the decrease in subcooling of the

condensate when circulating water flow through the main condenser stopped.

TEXT PAGE 3 OF 5

The failed bolts (ASTM A193 B7, sold as Cardinal Multi-bolts) were found corroded and pitted. Analysis of the bolts determined that they had failed due to stress corrosion cracking. The low torque which had been applied to these bolts during installation allowed the rotation of the flange mating surfaces, which would cock the bolts and induce high localized stress. The pitting appears to be due to the water chemistry present in the circulating water pit.

These bolts had been in service for 7 months before their failure. They had been installed during the 1992 refueling outage when seven (7) ASTM A307 Grade B bolts which had been installed in 1985 in the bottom column - impeller case flange were found broken or missing during a routine inspection. When consulted, the pump vendor recommended that the SAE Grade 2 bolts (ASTM A307 Grade B) be replaced with SAE Grade 5 bolts. Based on a letter from the Duane Arnold Engineering staff dated 1986 which approved the use of Multi-bolts as an appropriate substitute for SAE Grade 5, the Multi-bolts were installed and torqued to 62 ft-lb. This torquing value was obtained from the vendor. It has since been determined that the vendor had referred to an incorrect datasheet that is not applicable to this pump. The proper torquing value was 330 ft-lb for this type of high strength bolt.

III. ANALYSIS OF EVENT

All automatic actions occurred as designed. The control room operators responded to the loss of vacuum and subsequent reactor scram to restore the plant to a stable condition.

The loss of all circulating water flow through the main condenser is a non-limiting event.

IV. CORRECTIVE ACTIONS

1. The 'A' pump discharge piping was flanged off to allow plant operation with the remaining circulating water pump. The plant resumed operations with the remaining 'B' circulating water pump while the 'A' pump was off-site being repaired. The flange was removed and the 'A' pump was returned to service during the January 1993 maintenance outage. The bolts now installed in the 'A' pump are ASTM A307 Grade B.

2. The failed bolts were recovered and sent offsite for analysis.

TEXT PAGE 4 OF 5

3. The integrity of the bolts on the corresponding flange on the 'B' circ water pump was confirmed by in-place visual inspection during the 1992 refueling outage and by removal and inspection of two bolts during the 1993 maintenance outage. In addition, those bolts were confirmed to be ASTM A307 Grade B material; not the ASTM A193 Grade B7 material which had failed in the 'A' pump.

4. Additional vibration sensors were placed on the 'B' pump to monitor its performance and provide advance warning of pump degradation.

5. Two bolts from the 'B' circulating water pump were replaced during the January maintenance outage to verify their condition. Visual inspection and magnetic particle testing confirmed that these bolts were in good condition.

6. Engineering has established recommended torque values for the ASTM A307 Grade B bolts that will be used for refurbishing these pumps.

V. ADDITIONAL INFORMATION

1. Laboratory analysis of the failed bolting from the 'A' circulating water pump confirmed that the material was ASTM A193 Grade B7. Failures occurred by stress corrosion cracking in the shank under the bolt head and in the threaded area directly above the nut. Significant pitting was present on the bolt head and in the bolt head and shank areas.

2. The following factors were probable causes of the cracking:

The low torque value applied to the bolting material was insufficient to assure that the pump flanges were clamped and incapable of moving relative to one another when subjected to operating loads. The operation of the pump allowed the flanges to rotate and cock the bolts, which resulted in large prying stresses. Also, the relatively high strength bolt material is more susceptible to cracking. Finally, the pitting that was seen in the bolts is indicative of water chemistry in the pit that is conducive to stress corrosion cracking.

TEXT PAGE 5 OF 5

3. Previous Similar Events:

The bolts attaching the 'B' circulating water pump bottom column - impeller case flange failed in 1974. The bolts installed at that time were SAE C-1016 plain carbon steel. Those bolts had experienced severe pitting and wastage along the shanks. These bolts were replaced with ASTM A307 Grade B bolts per the vendor's specification. Both circulating water pumps were overhauled and their bolting replaced with ASTM A307 Grade B in 1980 and 1985. However, there is no record of the as-found condition of the old bolts. There are additional submerged bolted joints on these pumps which have not experienced failure. An NPRDS search did not uncover instances of similar failure.

4. EHS System and Component Codes:

Systems: AD - Reactor Recirculation System
NN - Circulating Water Structures
SG - Condenser System
JD - Reactor Protection System

Components: P - Pump

These events are being reported pursuant to 10CFR50.73(a)(2)(iv).

ATTACHMENT 1 TO 9303090544 PAGE 1 OF 3

March 2, 1993

To: L. Liu
L. Root
J. Franz
R. McGaughy
Safety Committee
K. Peveler
B. Mick
S. Swails
C. Bleau
P. Bessette
A. Binder
K. Shea (N&H)
INPO
GDS Associates, Inc.
Central Iowa Power Cooperative
Corn Belt Power Cooperative
DAEC Commitment Control

FROM: D. Wilson
Plant Superintendent - Nuclear

FILE: A-118a

Please find attached a revised copy of a Licensee Event Report that has been transmitted to the NRC.

LICENSEE EVENT REPORT NO. 92-018, Rev. 01

Notification Letter No. NG-93-0454

DR NUMBERS: 92-345

/eah

(6/91)

Copied via PROFS Note: R. Baldyga
D. Church
J. Edom
R. Hannen
T. Allen (STA Coordinator)
M. P. Flasch
W. Miller
A. Roderick
R. Salmon
P. Seckman
J. Thorsteinson
G. Van Middlesworth
T. Wilkerson

ATTACHMENT 1 TO 9303090544 PAGE 2 OF 3

March 2, 1993
NG-93-0454

Mr. A. Bert Davis
Regional Administrator
Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Duane Arnold Energy Center

Docket No: 50-331
Op. License DPR-49
Licensee Event Report #92-018, Rev. 01

Gentlemen:

In accordance with 10 CFR 50.73 please find attached a revised copy of the subject Licensee Event Report.

Very truly yours,

David L. Wilson
Plant Superintendent - Nuclear

DLW/RM/eah

cc: Director of Nuclear Reactor Regulation
Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D. C. 20555

NRC Resident Inspector - DAEC

ATTACHMENT 1 TO 9303090544 PAGE 3 OF 3

To: Routing

From: Leonard L. Sueper, Principal Technical Support Engineer

Subject: Concurrence with Outgoing Correspondence

Reference: LER 92-18, Rev. 1

Concurrence with and release of the referenced document is requested.

Originator

Technical Support Supervisor

Department Supervisor

Department Supervisor

A.P.S. - Operations Support

A.P.S. Operations

Operations Committee Chairman

/eah

*** END OF DOCUMENT ***
